Western Upper Peninsula Center for Science, Mathematics and Environmental Education & Sustainable Futures Institute

Western Upper Peninsula Center for Science, Mathematics and Environmental Education

Websites:
wupcenter.mtu.edu
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Drain to Drinking Water

Adapted from *Project WET Curriculum and Activity Guide*

Subject: Science, Social Studies
Target Grades: 6-8

Duration: one class period

Materials

Per group (2-3 students)

- 1 set of cups (with holes in bottom for drainage) for each student group containing:
  - Sand
  - Gravel
  - Charcoal
- 1 cup labeled "Clean Water"
- Cup of "Dirty Water"
  - Extra cups
  - Filter paper
  - Wax paper
  - Eye dropper
  - Alum
  - pH paper/pH scale
- Pencils & data sheets

Lesson Overview

Students consider where water goes once it has gone into the drain and how it gets cleaned to become drinkable again. Students will be the engineer and design a wastewater treatment process.

Essential Questions

Why do we need clean water?
How does water become polluted?
How do we remove pollutants from water?

Objectives

Students will be able to:

1. Identify the drains in their home
2. List the variety of wastes that go down the drain at home.
3. List the steps used to clean wastewater

Advance Preparation

To make wastewater, add the following items to one large container of water:

- Food wastes
- Shampoo
- Bleach
- Cleaners
- Laundry detergent
- Raisins
- Toilet paper
- Dish soap
- Paper litter

Room Arrangement: Students work in groups of 2-3 at four desks pushed together or at tables.

Safety: Don't eat any of the materials. Don't touch the materials until told to do so.

Background

When we turn on the faucet at home, we expect the water to be clean drinkable water, yet it wasn't always this way. Cities used to pump raw sewage from homes and businesses directly into rivers and lakes. Raw sewage used to be discharged directly into the Keweenaw Waterway from both Houghton and Hancock.

Our drinking water supplies became degraded to the point of causing serious health effects. In 1969 the Cuyahoga River, which flows through the city of Cleveland, had so much oily waste in that it caught on fire. In 1993, more than 100 people died in Milwaukee from bacteria getting into their drinking water from livestock runoff. It is true that nature is capable of cleaning water, but pollution created by millions of people and industry has overwhelmed nature's cleaning ability

Clean drinking water does not happen by accident. It can take quite a bit of work to get our water ready for drinking. And the waste water we send down the drain has to have a great deal of cleaning performed on it before that waste water is clean enough to release back into the environment.

Nature Can Clean Itself…

If there isn't too much pollution in water, nature can clean up itself:

- Flowing water mixes oxygen into the water which helps to clean the water
- Solids settle out of water
- Bacteria eat some waste products
- Time…

Procedure

Let's Do Some Calculating (*optional* - only for middle school students)

1. How much does a gallon of water weigh? *(8 pounds)*

2. How much water does the average American use each day? *(120-150 gallons per day)*

3. Let's say that a Space Shuttle trip has 5 astronauts on board, and they are on a 5-day mission. If each astronaut used 100 gallons of water each day, what is the total weight of water that would be required for the mission?

(5 people) (100 gallons water/person) (8 pounds/gallon water) = 4000 #/day
(4000 #/day) (5 days) = 20000 pounds, or 10 tons of water!

4. Now if NASA spends approximately $15,000/pound to send something into space, how much money would NASA spend to get 10 tons of water into space?
($15,000/pound) X (20,000 pounds water) = $300,000,000 (WOW!)

What would be a way to decrease the amount of water that NASA would have to send into space? Reuse the water. But wouldn't that require a great deal of cleaning? Sure, but it isn't that overwhelming a problem.

At Michigan Tech University, there is a team of researchers designing a process to improve NASA's water treatment system that could save millions in the years ahead. NASA spends $15,000 - $ 20,000 per pound to send anything up into space. By designing a water filtration system that will last longer before having to be replaced, they can save NASA millions of dollars per year! "The challenge is to find the most efficient combination of filters that will be most effective and last the longest," says Dr. David Hand of MTU's CEE Dept.

Activity 1: **Creating Wastewater**

A. Make Wastewater

1. Let's list the drains that we have in our homes: bathroom, kitchen, laundry room.
2. What materials do we send down our drains at home? I'll add items to this container as we list things.
3. Ta-da, WASTEWATER!
4. Your job is going to be to clean this water so it will be drinkable again! Is it really necessary to clean wastewater that much? YES! Think how many times the towns along the Mississippi River reuse the same water before it reaches the Gulf of Mexico. (Show map of U.S. highlighting towns along the Mississippi River)

B. Students Design Wastewater Treatment

Divide students into groups (or Environmental Engineering Teams) and distribute wastewater samples and cleaning materials.

1. Each group of "Environmental Engineers" has the following items to work with:
   - screen
   - filter paper
   - sand filter
   - gravel filter
   - alum
   - charcoal filter
2. Cups of sand and gravel have little holes in them to allow water to pass through. If you add water to these cups it WILL drain out. Be sure to capture water coming out of these cups.
3. Be sure to record your steps…you wouldn't want to have the cleanest water, but not know how to repeat the process! You have 20 minutes.

C. Compare Results

1. Compare your cups of "clean water." Whose is cleanest? Have group with cleanest water read the steps that they followed. Other groups compare what they did.
2. Evaluate: color, smell, pH, presence of oil.
3. What contaminants could not be removed by the methods available to you?

D. Nasty Compounds we put into water

1. Oil
2. Lawn Fertilizers & Pesticides (weed and bug killers)
3. Cleaners: many are caustic and diminish water quality
4. Paint thinner

Activity 2: **Wastewater Treatment** (*for most audiences*, shorten this to the headings only)

How many of you have visited a Wastewater Treatment facility? A wastewater treatment plant does in *nine* hours what it would take nature several weeks, or longer, to accomplish. Briefly explain the wastewater treatment process:

1. **Primary Treatment: Filtration and Settling** (Removes the Big Stuff)
   - Water flows through a large screen to remove big solids.
   - Water pumped into settling tanks where some solids settle to the bottom, or light stuff floats to the top and is skimmed off.
   - It is estimated that 45 to 50% of waste can be removed through this process alone.

2. **Secondary Treatment: Biological Processes**
   Promotes biological decomposition of waste by providing aeration.
   - Added microorganisms consume waste material in an aeration tank.
   - Solids and microorganisms are removed from water through another settling process.
   - It is estimated that 85 to 90% of waste can be removed though this process.

3. **Tertiary Treatment: Chemical Processes**
   - Not all treatment facilities have this stage of cleaning. (EXPENSIVE!)
   - Filtration through activated carbon: (removes pesticides and other organic molecules.
   - Distillation: Removes salts
   - Flocculation: Add a compound (like alum) that can cause suspended solids to stick together and settle out of water more easily.
   - Disinfectant, like chlorine bleach is added to kill disease-causing organisms.

Summary

Would you drink the water that you have "cleaned?" No, because you don't really know if this water is clean!! How do we know if water is clean enough to drink? Water is tested it---for bacteria, nitrates, etc. to be sure that it is safe to drink, by city water treatment plants. Or, if you have your own well, your parents need to get your water tested every few years to be sure its safe to drink.

We assume that the water coming out of our faucets will always be clean. Think about what happens to your waste the next time it goes down the drain. If you appreciate clean water, thank an *Environmental Engineer* the next time you turn on your faucet! If you want your drinking water to stay clean, don't pour anything on the ground that you wouldn't want to drink!

Clean Up

Rinse gravel and charcoal; throw out sand and filter papers, and leftover wastewater. Wipe desks. Put away in tub neatly. Make list of what needs to be replaced for next time.

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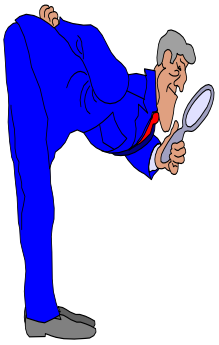
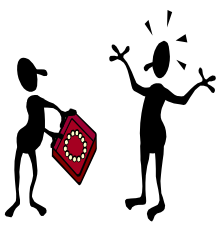
Cleaning Wastewater

Your mission is to clean up the wastewater we just made in class.



Ways to clean up your wastewater:

- Spoon
- Gravel Filter… holes in cup
- Charcoal filter… holes in cup
- Paper filter… holes in cup
- Screen
- Alum



First, discuss <u>what order</u> your group will use these different cleaning methods

Second, list the method in the table below.

Third, describe how well the method cleaned the water.

Order	**Cleaning Method**	How well did method work?
1	Spoon: scoop out chunks.	Worked well, but took too much time.
2		
3		
4		
5		
6		

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